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ABSTRACT

A study was conducted at two open-access, 2-year branch campuses of Ohio's Miami University to assess the levels of science anxiety, interest, and preparedness among students in science-related (SR) majors and general studies (GS) students. Surveys were distributed on the first day of class to students enrolled in 23 chemistry, microbiology, and physics classes in 1993-94, 1994-95, and 1995-96. Study findings, based on an analysis of 436 valid surveys, included the following: (1) 10% of the 242 SR students and 13% of the 194 GS students reported high anxiety; (2) 6% of GS students and 2% of SR students reported high levels of boredom, while low preparedness was reported by 26% of the GS and 13% of the SR students; (3) anxiety and interest scores correlated with exam scores for the GS group; (4) there was no correlation, however, between reported preparedness and exam scores for either group; (5) in responses to open-ended questions about anxiety, GS students cited subject-specific causes much more often than general causes compared to SR students; (6) high anxiety GS students were the most likely group of students to indicate that clear teaching would reduce their anxiety; and (7) none of the students who reported high anxiety levels suggested that an exciting teaching style could reduce anxiety. Contains 17 references. Data tables are attached. (JDI)

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SCIENCE ANXIETY ON A TWO-YEAR CAMPUS

Attitudes About Science Among Non-Majors at a Two-Year Campus of a Liberal Arts University

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Abstract

This study investigates self-reported anxiety, interest and preparedness among two groups of non-major undergraduates enrolled in science courses on a two-year open admissions campus. Scores on first exam were compared with the three attitudinal scores. Ten percent of the 242 science-related (SR) majors (e.g., allied health) and 13% of 194 general studies (GS) students reported high anxiety. Six percent of GS and 2% of SR students reported high boredom. Low preparedness was reported by 26% of GS and 13% of SR students. Anxiety and interest scores correlated with exam scores (r=0.26 and 0.32, respectively), but only for the GS group. There was no correlation between reported preparedness and exam score for either group. Students also responded to open-ended questions about causes and remedies of their anxiety. GS students cited subject-specific causes much more often than general causes of anxiety while SR majors traced their anxiety frequently to general causes. GS students reporting high anxiety believed in greater numbers than any other group that "clear teaching" could reduce their anxiety. No students reporting high anxiety suggested that an exciting teaching style could reduce their anxiety.

Attitudes About Science Among Non-Majors at a Two-Year Campus of a Liberal Arts University

Science anxiety has been extensively studied in all traditional educational age-groups. Many studies suggest that anxiety leads to lower achievement (Hembree, 1988; Mallow, 1981) although others show no clear relationship, or evidence for achievement being the antecedent to attitude among some age groups (Willson, 1983; Zoller and Ben-Chaim, 1990). Higher education in recent years has seen a tremendous increase in the number of non-traditional students, age 22 and up (Cross, 1988). Attitudes about science among this group are not well-studied, but the constant increase in their proportions on college campuses of all types is well documented. The numbers of students of all ages attending two-year, open-admissions institutions is also expected to increase in coming years. Many students in these populations report high-levels of science anxiety, and many fail to complete their science courses (Brown and Cranson, 1989).

Even though older students might be expected to have a higher degree of general self-confidence, evidence suggests that classroom anxiety is less influenced by student self-confidence than by a lack of a framework of prior knowledge (Anderson and Clawson, 1992). Also, anxiety often stems from students' perceived loss of personal control (Perry, 1991). According to Perry factors such as depression, crowding, marital relations, academic achievement, health, aging and stress contribute to perceived personal control. In the two-year campus setting, both traditional aged and older students are expected to experience many of these stresses. Also, many students in such a setting are first-generation college students, and may have been exposed to negative statements and

opinions about college in general, and science in particular. These experiences are expected to increase anxiety (Gogolin and Swartz, 1992; Mallow and Greenburg, 1983).

This study was undertaken at two regional campuses of Miami University and was designed to a) assess levels of student anxiety; b) separate anxiety from boredom or a lack of preparedness; c) examine the relationship between each of the three attitudes and performance; and d) solicit student input about science anxiety.

The survey population comprised non-majors enrolled in courses from chemistry, physics and microbiology departments. The study consisted of a survey form filled out by students and scores from the first exam in each course. Data for two types of non-majors were compared: the general studies student, for whom the science course may be their only college science experience, and the non-major from a related field, such as nursing or another allied health profession. During one typical semester of the six semester study, 59% of the undergraduate population was 22 years of age or more. Of these, 82% were between the ages of 22 and 30. Sixty-three percent of the undergraduate population was female.

Method

Survey design and testing

Surveys comprised ten statements to which students were asked to respond (agree or disagree) using a Likert-type scale (1-5). Each parameter (anxiety, interest) was measured by the averaged response to two questions which were directly related to the parameter in question. A third statement elicited answers which were inversely related to the parameter and was used to check internal validity of the survey answers. For example, the averaged response to the statements "I find science boring," and "I expect

(chemistry) to be boring" had to be at least 2 points different from the statement "I'm looking forward to this course" or the survey was discarded. Only two of 438 surveys were discarded for this reason. One unrelated statement was also included on the survey. Also, surveys contained four open-ended questions about the course and/or subject matter, two of which asked students to identify causes and remedies for anxiety about the course, and two which were unrelated.

We did not use an existing survey instrument because we wanted a very short survey which probed preparedness and boredom levels as well as anxiety. Questions were adapted from existing instruments such as the Scientific Attitude Inventory (Moore and Sutman, 1970) and the Attitudes Toward Science Inventory (Gogolin and Swartz, 1992). Survey statements were assessed for validity before the study began by administering them to 40 students, and then asking them to directly rate their levels of anxiety, interest, and level of preparation on a Likert-type scale. Scores on the surveys closely approximated self-reported levels of the three parameters. Copies of the survey are available from the authors.

Survey administration

Students in 23 classes taught by eight different instructors in the departments of chemistry, microbiology and physics were surveyed during academic years 93-94, 94-95, and 95-96. Courses offered to non-majors to fulfill the liberal education requirement were designated GS, or general studies. Courses taught for students majoring in a science-related field, such as allied health or nursing were designated SR, or science-related. A total of 436 valid surveys were obtained (Table 1). Surveys were administered on the first day of class by the course instructor or a surrogate after the syllabus had been

distributed but before any class discussion. Surveys were immediately turned over to study personnel, and course instructors did not see them. Students used self-invented code names and were assured of anonymity.

Scores on the first semester exam were collected on the day exams were handed back. Students turned in the scores accompanied by their code names. Eleven percent of SR majors and eight percent of GS students did not turn in first exam scores, either because they had dropped the course by that time or they declined to participate in this phase of the voluntary study.

Data analysis

Each respondent was assigned an anxiety, lack of interest, and preparedness score based on responses to the Likert-scale statements on the survey. Anxiety and lack of interest (boredom) scores of 4 or above were designated "high"; preparedness was designated "low" if the score was 2 or below. Answers to open-ended questions were placed in several possible categories independently by two investigators and discrepancies in categorization decided together. Chi-square analysis was used to assess differences in the three parameters of anxiety, interest, and preparedness between general studies and science-related students. The Pearson correlation coefficient was used to describe the relationship between exam scores and each of the parameters.

Results and Discussion

Attitudes toward science

More than a quarter of general studies (GS) students consider themselves to be underprepared for a science course (Table 2). This is true even though course materials clearly state that there are no prerequisites. Not unexpectedly, their level of boredom

with the topic is also higher than students enrolled in a science-related major (SR). Approximately ten percent of both types of students reported high levels of anxiety. Apparently, the self-reported low level of preparedness among GS students did not translate to correspondingly high anxiety.

When the beliefs and attitudes of the two populations of students were paired with performance on the first exam, anxiety and boredom were negatively correlated with exam score, but only for the general studies students (Table 3). Therefore, while SR students report similar levels of anxiety as GS students, it may not affect their performance in the class. Some investigators have found that among the most able students, anxiety is correlated with enhanced performance (Spielberger and Gaudry, 1971). This phenomenon, or some form of it, may be one factor influencing this finding. While the three parameters of anxiety, boredom, and preparedness account for 73% of the variance in GS test scores, the low correlation coefficients found for these parameters among SR students suggests that their performance is affected by a more complex web of attitudes and circumstances which this survey did not address. Since similar proportions of students in the two groups failed to submit exam scores, and since it was not determined how many of these "drop-outs" were due to dropping the course or simple refusal to participate, no conclusions can be drawn about the effect of course drop-out in the two groups.

The correlation analysis provides evidence that reducing anxiety and boredom may improve the performance of GS students in science courses. But since a secondary goal of many science departments is also to engage non-majors in the experience of science we believe that reducing anxiety and boredom is a worthy goal for instructors of

all types of non-majors, whether or not it results in better test scores. We should also remember that test scores, used in this study as an indicator of success in the course, may not accurately reflect learning.

Student input

When survey respondents were asked on open-ended questions to identify their single greatest source of anxiety, general studies students listed subject-specific concerns much more often than they cited general complaints. This was true of those reporting high anxiety as well as the whole population (Table 4). Science-related majors' concerns were more evenly distributed between subject-specific and general categories. This is not a surprising result, since SR majors would be expected to be made less nervous by the content of science. A nihilistic attitude, which appears frequently in anecdotal reports from campuses with a large proportion of non-traditional and underprepared students, can be seen in the statement "I'm bad in science", cited frequently by GS students (11% of entire sample), but also in the high-anxiety subset of the SR students (4/24 responses, or 17%). Frequent subject-nonspecific responses were "I need a good grade", "I have test anxiety", and "I've heard this class is hard" (hearsay). This last response, which showed up frequently among SR students, is an interesting finding which may point to the "clique-ishnes" of those in health science programs and those trying to gain entrance. Nursing students, for example, tend to discuss their courses (and instructors) at great length. This data suggests that preconceptions are brought to the first day of class and may negatively impact the experience, if not the performance, of students in the course. It might be an area which can be addressed in orientation programs and advising sessions with some success.

When all students (low and high anxiety) were asked what could reduce their anxiety, there was little difference in responses given by general studies and science-related majors. Approximately 10% of both groups cited "going slowly" and "instructor accessibility" as important (data not shown). Thirty and 35% of GS and SR students, respectively, made suggestions which fell in the category of "clear explanations and lecturing". This is not surprising since we know that among students with low anxiety "good" teaching behaviors improve students' experience of science (Marsh, 1984). Some research also suggests, however, that students with higher anxiety do not respond as well to improved teaching strategies (Perry and Dickens, 1984).

Differences between the two student groups in this study became apparent when high-anxiety students were asked to identify things that would reduce their anxiety (Table 5). Here the general studies students still overwhelmingly cited clear explanations as a remedy to anxiety. Half as many of these students mentioned "having a helpful accessible instructor" , and "using laymens' terms – putting science in context" . This latter suggestion also appears frequently in science anxiety literature (Hurd, 1993; Mallow, 1978). Science-related majors' suggestions were evenly spread among three remedies (Table 5). They did not mention a need for contextualizing the material, presumably because their related major provides them the context. While small percentages of students in both of the larger groups sought an exciting and dynamic professor, no student in either high-anxiety group mentioned this as a possible remedy for anxiety. This indicates that it is not a lack of interest which makes students anxious about science courses. If this is the case, it is clear that instructors of science can have a great impact on students who want to learn, but are "put off," perhaps by the pedagogy.

We can not exclude the possibility that observed differences were due to differing proportions of chemistry, physics and microbiology students in the two groups. However, subsequent focus group discussions with both general studies students and science-related majors in each of the these three courses indicated that student attitudes differed along category (GS vs. SR), rather than subject lines.

Conclusions

Significant numbers (at least 10%) of science non-majors on the campuses sampled here experience high levels of anxiety about their science courses, whether they are majoring in related disciplines or not. In courses designed for general studies students, anxiety may be associated with a lower level of performance. The sources of anxiety differ for these two types of non-majors but the remedies suggested by students themselves are similar. Many of their answers, such as providing context, echo remedies suggested in the science anxiety literature (Mallow, 1978). Other oft-cited anxiety remedies could also address the sources of anxiety mentioned by the students in the study. Teaching specific reading skills for science, for instance, could reduce the impression that this is a "hard topic", one that is out of reach for non-majors. Learning special science reading methods also could serve to compensate for a lack of prior knowledge (Anderson and Clawson, 1992). Even pedagogical tools, such as the syllabus, can be designed to reduce anxiety, for instance by providing less information and more flexibility (Smith and Razzouk, 1993).

Boredom was also found to be prevalent, especially among GS students. It was also associated with poor performance. Instructors are probably more accustomed to inventing strategies to alleviate boredom than anxiety, but some of the solutions offered

by students might serve to do both. For instance, by contextualizing the topic, instructors can heighten student interest and address the anxiety induced by feeling that it's been too long since a student's last science course, or the more general hopelessness indicated by statements such as "I'm bad in science" (Hurd, 1993). Reminding students how much they already know, through pre-tests which incorporate life experiences with the topic, or citing news media coverage of class topics are ways to provide context.

Most of the strategies identified by students in this study are relatively easy to implement, and may result in big dividends if students emerge with better attitudes about science.

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Table 1

Courses Included in Study

	Number of sections	Total students
Courses for General Studies Students		
Chemistry in Modern Society (CHM 111)	3	19
Microorganisms and Human Disease (MBI 111)	3	68
Astronomy and Space Physics (PHY 111)	3	51
Introduction to Atmospheric Science (PHY 118)	3	56
Total	12	194
Courses for Science-Related Majors		
Chemistry of Life Processes (CHM 131)	5	72
Elementary Medical Microbiology (MBI 161)	5	159
College Physics (PHY 171)	1	11
Total	11	242

Table 2

Anxiety, Boredom and Preparedness

Attitudes	General Studies	Science-Related
	n = 194	n =242
High Anxiety (score ≥ 4)	13%	10%
High Boredom (score ≥ 4)	6%	2%*
Low Preparedness (score ≤ 2)	26%	13%**

* $p < 0.05$

** $p < 0.01$

Table 3

Relationship Between Anxiety, Boredom or Preparedness and First Exam Score

	r^a
General studies students	
n =159	
anxiety vs. exam score	0.26
boredom vs. exam score	0.32
preparedness vs. exam score	0.15
total	0.73
Science-related majors	
n = 215	
anxiety vs. exam score	0.13
boredom vs. exam score	0.08
preparedness vs. exam score	0.11
total	0.25

[a] Pearson correlation coefficient

Table 4

Self-Reported Sources of Anxiety

All Respondents

Type of anxiety	GS n = 194	SR n = 242
Subject-specific	50%	42%*
examples[a]	too long since last science (12%[b])	hard topic (15%)
	"I'm bad in science" (11%)	too long since last science (10%)
Other	14%	35%***
examples	------[c]	hearsay (7%)
		need good grade (7%)

High Anxiety Respondents

Type of anxiety	GS n = 25	SR n =24
Subject-specific	64%	38%
	(16/25[d])	(9/24)
examples	"I'm bad in science" (10/25)	"I'm bad in science" (4/24)
	hard topic (5/25)	too long since last science (3/24)
		hard topic (2/24)
Other	20%	46%*
	(5/25)	(11/24)
examples	need a good grade (3/25)	nontraditional student (4/24)
		need a good grade (4/24)
		test anxiety (3/24)

Note. Column totals do not equal 100% due to nonresponses to the open-ended question, or stated denial of anxiety.

[a]responses given by ≥7% of respondents are listed

[b]percentage of all responses, both subject-specific and "other"

[c]no single response was given at a frequency of ≥7%

[d]raw data are provided due to small sample sizes

*$p < 0.05$

***$p < 0.005$

Table 5

Self-Reported Remedies for Anxiety Among High-Anxiety Respondents

	General Studies	Science-related
Suggested remedies	n = 25	n = 24
clear explanations/lecture	8/25	4/24*
use layman's terms/contextualizing	4/25	0/24*
helpful, accessible instructor	3/25	4/24
go slowly	2/25	5/24*
exciting presentation style	0/25	0/24

*$p < 0.05$